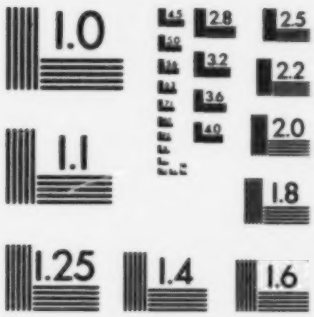
MS109

Micromedia Limited



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

This statement was filmed with this document.
If the pages of the document are less clear
than this statement it is due to the poor
photographic quality of the document.

NATIONAL MICROGRAPHICS ASSOCIATION

24x

MSP-86-01

Field Trials of Lignosulphonate Dust Palliative

Ontario

Ministry of
Transportation and
Communications

Research and
Development
Branch

86-04270/

Technical Report Documentation Page

MTC Report Number MSP-86-01	ISBN Number:	Other Document Number:	Date: June 1986
Title: Field Trials of Lignosulphonate Dust Palliative			
Authors: J.I. McDougall Head, Geotechnical Section MTC Northern Region			
Published by: The Research and Development Branch, Ministry of Transportation and Communications		**Client Group:**	
Participating Agencies:			

Abstract:
This report addresses the effectiveness of an ammonium lignosulphonate in comparison to other dust palliatives in common use in Ontario on rural gravel roads.

A literature review summarizes some of the concerns and comments about the use of lignosulphonates as a stabilizer and dust palliative.

The results of a questionnaire gives an idea of the number of agencies using lignosulphonates and the application rates they use.

Field tests performed in 1984 in Huntsville District indicate that lignosulphonates were most effective on sedimentary, high fines crushed rock and less effective on igneous, medium to low fines, crushed gravels. The tests also indicated the lignosulphonates to be less effective than road oil and nearly as effective as calcium chloride.

This report recommends precautionary use of lignosulphonates as dust layers, when cost effective, with high fines (non clay) gravel, where arid conditions prevail, in areas not close to trout streams, ponds or potable water sources.

Key Words: ammonium lignosulphonate, dust palliative, road oil, calcium chloride, dust stabilizer, Tembind

Comments: This report was previously titled Report on 1984 Field Trials of Lignosulphonate Dust Palliative Mini-Research # 85/2M.

Distribution: Regional Directors; Quality Assurance and Geotechnical Section Heads; Maintenance, Municipal and District Engineers.

Copyright Status: Crown copyright

MSP-86-01

Field Trials of Lignosulphonate Dust Palliative

J.I. McDougall
Head, Geotechnical Section
MTC Northern Region

Published by:
The Research and Development Branch
Ontario Ministry of Transportation and Communications
Hon. Ed Fulton, Minister
D.G. Hobbs, Deputy Minister

Published without prejudice
as to the application of the findings.
Crown copyright reserved; however, this
document may be reproduced for non-commercial
purposes with attribution to the Ministry.

For additional copies, contact:
The Editor, Technical Publications
Ontario Ministry of Transportation and Communications
1201 Wilson Avenue
Downsview, Ontario
Canada M3M 1J8
(416) 248-7226

June 1986

TABLE OF CONTENTS

PAGE

ACKNOWLEDGEMENTS iii

1/ INTRODUCTION 1

2/ BACKGROUND 2

3/ LIGNOSULPHONATES 3

4/ LITERATURE REVIEW 4

5/ SURVEY RESULTS 5

6/ FIELD TRIALS 6

7/ ENVIRONMENTAL REPORT 7

8/ DISCUSSION AND CONCLUSIONS 13

9/ BIBLIOGRAPHY 14

APPENDIX A/ SURVEY OF RESPONDERS 18

APPENDIX B/ APPLICATION METHODS. 29

APPENDIX C/ PHOTOGRAPHS OF APPLICATION METHODS 34

APPENDIX D/ 1985 ENVIRONMENTAL TEST 41

APPENDIX E/ TABLE 1: PRODUCTION PARTICULARS, CANADIAN PULP & PAPER MILLS. 47

TABLE 2: TEMBIND 35 ROADWAY SITES 52

ACKNOWLEDGEMENTS

The author would like to thank the following for their help assembling this report:

J. Newton,
D.A.O. White,
B. Roberts,
R. Aquin,
W. Zonnenberg,
A. Pinkerton,
and the authorities who took the time to respond to the questionnaire.

1/ INTRODUCTION

A minor field trial of lignosulphonates in Northern Region in 1983 showed some promising results. Mr. S.G. Wilson, then Head of Northern Region Geotechnical Office, proposed a mini-research project to further analyse the effectiveness of lignosulphonates as a dust palliative. The project received approval early in 1984.

Under the direction of W. Zonnenberg, Senior Research Engineer, Research and Development Branch, and with the consent of Northern Regional Director, J.E. Heffernan, a team comprised of Messrs. Zonnenberg, B. Roberts (Northern Region Environmental Unit), J. Newton (Huntsville Municipal) and the author met to plan the project. It was decided that J. Newton, Municipal Foreman, in consultation with R. Aquin of Head Office Bituminous Section, and M. Cressman of Can-Am Oil Services would devise a program of test. In the meantime, W. Zonnenberg and the author devised a questionnaire and had it sent to other road agencies. B. Roberts, Senior Environmental Planner, was able to obtain the services of a keen undergraduate science student, Christine Norman, to research and monitor the environmental effects at two of the test areas. Their report, issued in September 1984 describes their findings and recommendations. Excerpts from the report are included in Appendix E of this report.

In this report, the author reports field results, gives an overview of the use of lignosulphonates, directs the reader's attention to the main characteristics of the product, and sites factors to consider when selecting it as a dust palliative.

2/ BACKGROUND

Ever since man began to travel the beaten paths, airborne dust from unsurfaced roads and trails have been a problem during dry summer weather. Dust reduces sight distance, infiltrates homes and vehicles, and covers roadside vegetation. It is not only a nuisance but can have an adverse effect on human health, especially if it contains high levels of silica or asbestos.

A local industry (Tembec) recently approached the Ministry to seek acceptance of their lignosulphonate dust palliative product. After a relatively successful trial in 1983, it was felt desirable to have a well-designed approach to compare the product with other available palliatives. In the meantime, it was also felt desirable to send out a questionnaire to other road agencies and to review the literature on lignosulphonates. Thus, Mini-Research Project 84/2M was commenced in Northern Region, with trials also monitored in Southern Ontario.

3/ LIGNOSULPHONATES

Lignin, one of the major constituents of wood, comprising 33-40% of its dry weight, is separated from the other major constituent, cellulose by a process of sulphonation in the sulphite process of the pulp and paper production. Cellulose is used as the major constituent of paper. By-products, such as sulphonated lignin, other sugars, and etc., are used in a variety of other products. Lignosulphonates functions well in:

- adhesive applications such as feed binder, briquetting, road stabilizing, binders for mining and metallurgical applications, and components in adhesives formulations,

- dispersant applicants for oil well drilling, e.g., cement and concrete, gypsum board, ceramic materials, and agricultural spray dispersants, and

- tanning animal hides.

When lignosulphonates are used as a dust palliative they are neutralized to form a non-corrosive product at a concentration which allows them to be both sprayable and able to wet and penetrate the gravel surface. There are many lignosulphonates at many solid concentrations, for example, calcium-, sodium-, and ammonium-lignosulphonates at 25, 35 and 50% solids.

Not all sulphite pulp and paper mills retrieve their lignosulphonates for dust palliative purposes; see Table #1200S/1 and 1200S/2 (attached to response from the Pulp & Paper Research Institute dated May 8, 1984 for those which presently are retrieving the product in Canada.)

A more thorough description of lignosulphonates and derivatives may be found in the sources listed in the Bibliography.

4/ LITERATURE REVIEW

A literature search by the authors revealed that Ontario, as well as many other road agencies, have been experimenting with lignosulphonate waste products over the last 30 or more years. For example, these have been used as dust palliatives, road stabilizers, and anti-frost heave additives as well as binders for feeds, fertilizers, tanning agents, and asphalt extenders.

A recent survey (1983) by Public Works Canada on dust treatment and surfacing practices indicates that several Provinces have used or are using lignosulphonates. In summary, the survey shows that calcium chloride is the most commonly used palliative; that oils have longer and lignosulphonates shorter periods of retention than calcium but lignosulphonates may be more cost-effective in arid or semi-arid climates.

Five dust suppressants dominate the industry: calcium chloride, water, petroleum products, wetting agents and lignosulphonates. These vary in lifespan: some will only last 30 minutes, others a year or more. The environment, road-base materials, traffic, and amount of dust palliative used will all effect the longevity of the treatments. Some of the products are easier to apply than others. There are environmental concerns with them all, except perhaps water (providing it isn't acid rain).

The product that is easiest to apply, longest-lasting, of least cost, readily available and environmentally safe will, of course, be the one all users will be looking for.

In general, calcium chloride appears to be favoured in most of the above categories, followed by road oil and lignosulphonates respectively. Except in arid climates, lignosulphonates are unattractive because they are water soluable, of some hazard to aquatic life and expensive compared to other products.

5/ SURVEY RESULTS

A survey (Appendix A) was sent to 24 agencies in Canada and the Northern United States. Response to our questionnaire was 67%, with 20% of these either using or having used lignosulphonates as a dust suppressant. 50% preferred calcium chloride as their main dust suppressant. Some of the responders had no gravel roads under their jurisdiction. These results strongly indicate that calcium chloride dominates the dust suppressant market.

Some magnesium chloride is used and emulsified asphalts are common. There are some environmental concerns about the use of salts especially in areas where orchards predominate.

Several of the western provinces have experimented with lignosulphonates and are using them on a cost-effective basis with preference in the arid regions (e.g., the interior of British Columbia). Potholing of lignosulphonates treated roads are repaired with cold mix and/or rescarified after a good rain.

Because some responses did not specify the percentage of solids used in the application of lignosulphonates, it is hard to judge what application rates are most common. Indeed, some agencies use two applications, with the second application late in the year.

A list of authorities were surveyed and their remarks are included in Appendix A.

6/ FIELD TRIALS

A number of trials were carried out in 1984 using several methods (see Appendix D for Program of Test) the majority of which took place in the Huntsville District under the supervision of Jack Newton (see Appendices C, D and F).

A trial by the Township of Casey (Appendix C) in the New Liskeard District by Township Forces using application method D (Appendix B) was compared against liquid calcium chloride.

A number of the municipalities in the vicinity of Kapuskasing obtain lignosulphonates from the Spruce Falls Power and Paper Company Mill free of charge and are very satisfied with its dust suppressing capabilities. These municipalities could not afford to use liquid calcium.

In Southern Ontario, a number of trials took place and are reported in Evaluation of Tembind 35 Dust Palliative[1]. In Southern Ontario, in about 15 locations, Tembind 35 (35% solids) was compared with either waste oil or calcium chloride. Tembind 35 costs were comparable to waste oil although the procedures for application were not performed as they were in Northern Ontario and the rate of application was considerably lower. Performance was rated from fair to good and the authors favoured the continued use of the product. The same observations were sited many times in the northern experience.

[1]R.C. Aquin, P. Korgemagi and D.F. Lynch, Evaluation of Tembind 35 Dust Palliative, Report No. MI-83, Engineering Materials Office, Ministry of Transportation and Communications, Downsview, January 1986.

7/ ENVIRONMENTAL REPORT

The Environmental Unit of Planning and Design, Northern Region, researched the environmental effects of lignosulphonates, and carried out field research on two of the sites. These efforts resulted in a report by C. Norman and B. Roberts: Lignosuphonates as a Dust Suppressant -- An Environmental Assessment[2]. The report addressed the environmental concerns associated with using spent sulphite liquor as a means of dust control.

A literature review summarized the effect on soil, terrestrial and aquatic life, domestic water supply and animal/human toxicity. Field tests indicate that it is possible for significant concentrations to leave the road during rainfall periods, and collect in roadside ditches and ponds. The main area of concern appears to be the possibility of adverse effects on aquatic organisms.

The report contains guidelines and precautionary steps to be considered before using lignosulphonates as a dust palliative. It also recommends topics for further study. The following are excerpts.

Recommendations and Further Study Suggestions

Recommendations

It appears that the problem areas would be non-flowing water bodies adjacent to the treated road, and small streams in high run-off locations.

Prior to application, the area should be surveyed for roadside water bodies supporting fish life. It should then be determined if they are in a prime location for run-off. For example, Area 1 had a sampling site at the bottom of a long slope and very high concentrations were recorded there. The Ministry of Natural Resources can be contacted to provide information on any sensitivities in the area (i.e. spawning beds, coldwater streams supporting trout).

[2]C. Norman and B. Roberts, Lignosulphonates as a Dust Suppressant -- An Environmental Assessment, Ministry of Transportation and Communications, Northern Region, North Bay, Ontario, August 1984.

If a potential problem exists, another method of dust suppression, one more resistant to run-off, should be chosen.

If the surface is treated with spent sulphite liquor then certain precautions should be taken.

Periodic checks to ensure that the pH has been neutralized at the mill are advisable.

Proper pre-application preparation of the road surface is necessary. The road should be graded, with windrows bladed on both sides of the road, for mixing later on. This mixing is important in decreasing run-off.

Application should be made when no rain is expected for 24 hours. This allows time for the product to dry out and harden.

Some experimentation will be necessary to determine the amount of spent sulphite liquor to be applied. If pools form on the road surface, a decrease in the application rate is necessary.

As well, rinsing and cleaning the spray truck and hose should not take place in the vicinity of a water body or, for aesthetic reasons, in built-up areas of nearby towns.

Jack Newton of MTC, Huntsville District, monitored these field trials. He concluded that the product performance was not high enough to offset the cost of the product.

Further Study Suggestions

Relative Toxicity of Different Bases

More information is needed on the relative toxicity of the bases used.

A. Wong's findings on the increased toxicity of the ammonium-based spent sulphite liquor needs to be substantiated. This would involve a more extensive literature search, and possibly some toxicity tests.

Also, although the percent nitrogen is known for the ammonium-based spent sulphite liquor, this needs to be broken down into the percent nitrate, and the percent free ammonium. The presence of high levels of these two in water is cause for concern.

Lignosulphonates vs Other Forms of Dust Control

A study should be considered which compares the environmental impacts of all major forms of dust suppression, and gives recommendations.

Detection of Spent Sulphite Liquor

A more accurate means of detecting spent sulphite liquor in water is desirable. The conductivity-concentration relationship minimum detection level is 100 ppm.

Hach Ltd. sells the Tannin and Lignin Test Kit (Cat. No. 1937-01) to an accuracy of 0.5 ppm. This is a colourimetric procedure that detects aromatic hydroxly groups. The applicability of this method for field measurements should be investigated in light of its ease of use in the field.

Testing of Downstream Dilution

To determine to what extent impacts are reduced downstream, a test area should be set up with a stream crossing and to measure downstream dilution. An efficient means of doing this would have to be set up.

Migration of Spent Sulphite Liquor in Soil

Effect of spent sulphite liquor on wells within the area of application (sic). A study of this type might take place over several years.

Effect of Spent Sulphite Liquor on Oxygen Levels

Monitor effect of spent sulphite liquor on the oxygen demand (both biological and chemical) in adjacent water bodies (sic).

Quality Control

A chemical analysis should be done to see if any modifications in the liquor have taken place between the mill, the supplier, and the site of application.

Effect of Rainfall on Product Performance

Conflicting reports on the products' effectiveness indicate that it is very dependent on weather conditions. Determining the maximum precipitation allowable in a region before the lignosulphonate becomes ineffective would be beneficial.

Effect of Compaction on Product Performance

The roll compaction (with rollers) plays in lowering the permeability of the road surface and subsequently increasing the treatments resistance to rainfall should be evaluated.

Importance of Road Soil Make-up on Effectiveness

The road soil make-up plays a role in the product's effectiveness. If the road material doesn't contain a good distribution of particle sizes, is it economical to add, for example, fine particles to sandy or gravelly soils?

Factors Diminishing Effectiveness

Is the effectiveness diminished solely by run-off of the product or are other factors involved?

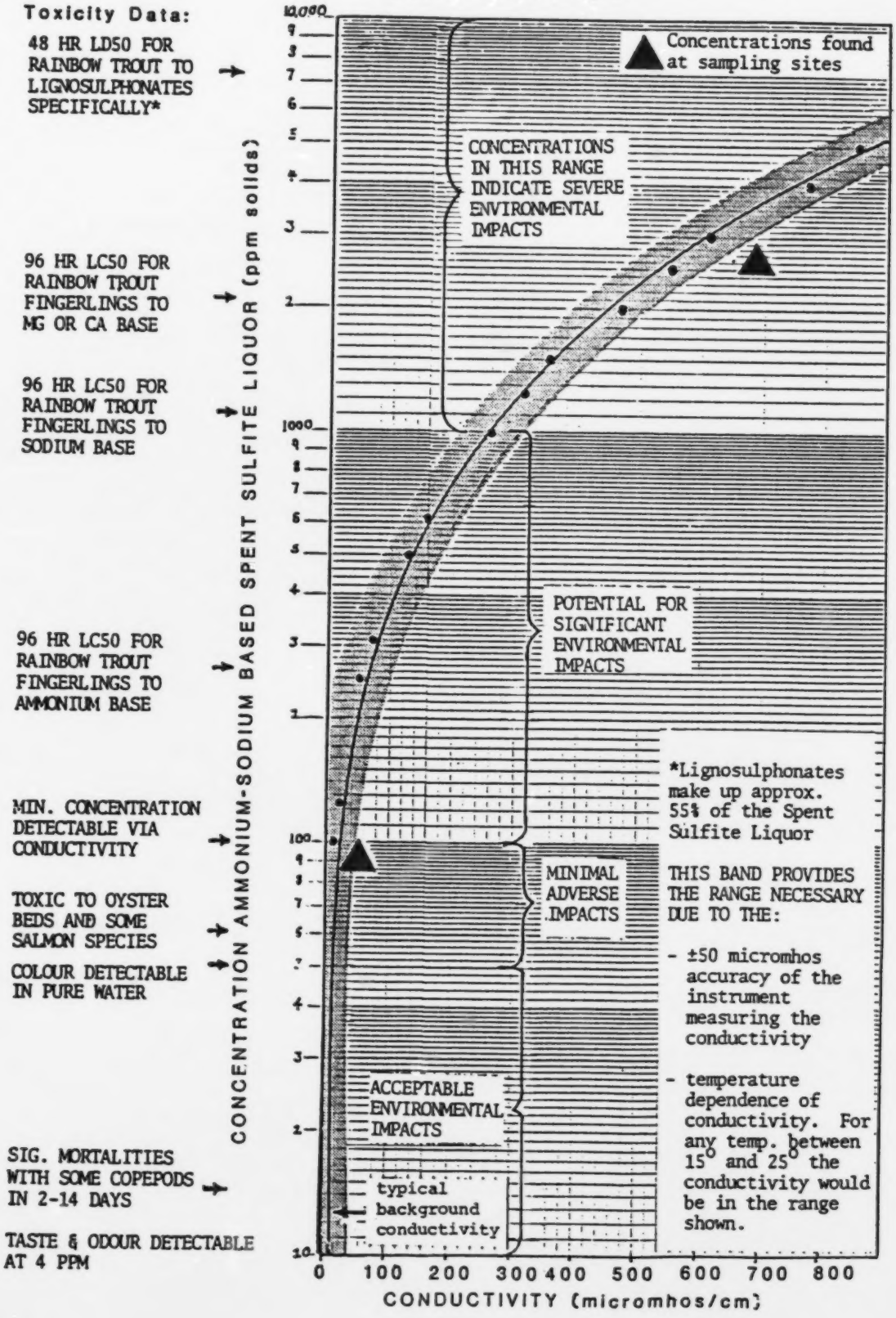
Conclusions

Spent sulphite liquor is a waste product that is produced in large quantities; one sulphite mill in Quebec produces approximately 350 tonnes (2-3% solids) per day. An alternative to dumping the waste directly into nearby water bodies is extremely desirable. Its use as a dust suppressant is one of these alternatives, and would lessen the stress on rivers somewhat. This is only beneficial, however, as long as it is not merely transferring the pollution problem to another location.

If the recommendations are followed, the use of spent sulphite liquor as a dust palliative should be acceptable and continued until more definitive answers can be found to the concerns raised.

(NORMAN & ROBERTS)

Figure 1 Concentration vs Conductivity Ammonium-sodium Based Spent Sulfite Liquor


Toxicity Data:
48 HR LD50 FOR RAINBOW TROUT TO LIGNOSULPHONATES SPECIFICALLY*
96 HR LC50 FOR RAINBOW TROUT FINGERLINGS TO MG OR CA BASE
96 HR LC50 FOR RAINBOW TROUT FINGERLINGS TO SODIUM BASE
96 HR LC50 FOR RAINBOW TROUT FINGERLINGS TO AMMONIUM BASE
MIN. CONCENTRATION DETECTABLE VIA CONDUCTIVITY
TOXIC TO OYSTER BEDS AND SOME SALMON SPECIES
COLOUR DETECTABLE IN PURE WATER
SIG. MORTALITIES WITH SOME COPEPODS IN 2-14 DAYS
TASTE & ODOUR DETECTABLE AT 4 PPM
CONCENTRATION AMMONIUM-SODIUM BASED SPENT SULFITE LIQUOR (ppm solids)
10,000
1000
100
10
Concentrations found at sampling sites
CONCENTRATIONS IN THIS RANGE INDICATE SEVERE ENVIRONMENTAL IMPACTS
POTENTIAL FOR SIGNIFICANT ENVIRONMENTAL IMPACTS
MINIMAL ADVERSE IMPACTS
ACCEPTABLE ENVIRONMENTAL IMPACTS
typical background conductivity
*Lignosulphonates make up approx. 55% of the Spent Sulfite Liquor
THIS BAND PROVIDES THE RANGE NECESSARY DUE TO THE:
- ±50 micromhos accuracy of the instrument measuring the conductivity
- temperature dependence of conductivity. For any temp. between 15° and 25° the conductivity would be in the range shown.
0 100 200 300 400 500 600 700 800
CONDUCTIVITY (micromhos/cm)

8/ DISCUSSION AND CONCLUSIONS

From observations of the 1984 trials in Ontario and in light of a literature search and the responses to our survey, the following can be reported:

- Both success and failure have been observed when using lignosulphonates in Ontario in 1984. Failures are due to loss of dust palliative due to rains and, according to some respondents, due to the application on unconsolidated gravel roads.

- Outside Ontario, other users and former users indicate that where dust palliatives are competitive in market value and where arid conditions prevail, lignosulphonates perform well.

- Wholesale acceptance of lignosulphonates may not be cost-effective in Ontario given its normal climatic conditions and 1984 prices. This, of course, is a challenge to industry to be cost-competitive and to follow-up on any problems as they arise.

- Caution is advised in the use of the lignosulphonate material near trout spawning areas (as would also be the case when using other dust palliatives).

- The use of asphaltic materials should be considered for use in fruit/tree/agricultural areas as well as near environmentally sensitive water courses in lieu of calcium chloride or other salts.

- Further trials and joint testing between the industry and MTC would help (i) to answer the environmental concerns, (ii) to discover the correct application rates and procedures, and (iii) to develop an alternate bid specification for liquified calcium or lignosulphonate.

Note: the MOE, MTC, Can Am-Oil Services and Temfibre Inc. tested and monitored an application of Tembind in Southeastern Ontario June 7 to July 18, 1985. Results from this test (Appendix D) indicate that "there is no good reason to prohibit the use of Tembind as a road suppressant...".

9/ BIBLIOGRAPHY: SPENT SULPHITE LIQUOR AND LIGNOSULPHONATES AS A DUST SUPPRESSANT

In a literature and file search for publications about dust suppressants, the following publications and reports were noted. Some of these refer to other publications which are not included in this list.

Aquin, R.C.; September 1982
Bond-All Dust Palliative -- Interim Report
Engineering Materials Office, Ministry of Transportation and Communications, Unpublished Report.

Aquin, R.C., P. Korgemagi, and D.F. Lynch; 1986
Evaluation of Tembind 35 Dust Palliative
Engineering Materials Office, Ministry of Transportation and Communications, Report No. MI-83, January 1986.

Bohn, R. et al; February 1981
Dust Control for Haul Roads
Midwest Research Institute, Kansas City, Mo., Prepared for the U.S. Bureau of Mines, BU MINES OFR 130-81.

Bollen, W.B.; April 1985
Microbial Transformations and Effects of Dehydrated Ammonia-Base Sulphite Liquor Spent Liquor in Soils
Oregon Agricultural Experiment Station, Cornvallis, Oregon TAPPI, Vol. 38, No. 4, April 1985, pp. 208-215.

Boyd, K.R. and Van Cauwenberge; December 1980
Evaluation of Calcium Lignosulphonates as a Dust Palliative
Province of Manitoba, Department of Highways and Transportation, Materials and Research Division, Research Project 80-2, Report #1.

Boyd, K.R.; November 1983
Evaluation of Lignosulphonates as Dust Palliatives
Province of Manitoba Department of Highways and Transportation, Materials and Research Division, Research Project 80-2, Report #3.

Brownridge, F.C.; October 1964
Frost Heave Treatment with Lignosol (Calcium Lignosulphonate)
Ministry of Transportation and Communications, Ontario, Unpublished Report.

Chong, G.J.; March 1972
Granular Stabilization with Lignosol
Engineering Research Branch, Ministry of Transportation and Communications, Ontario.

Cooper, J.A. and Aquin, R.C.; September 1983
Petro-Tac Dust Palliative
Engineering Materials Office, Bituminous Section, Ministry of Transportation and Communications, Ontario, Report MI-58.

Hoover, J.M.; June 1971
Surface Improvement and Dust Palliation of Unpaved Secondary Roads and Streets
Engineering Research Institute, Iowa State University, ISU-ERI-AMES 99991, Project 856-S.

Khodari, A.; 1984-01-20
Report on the Usage of Lignosulphonate
Government of Quebec, Ministry of Transportation.

Lake States Roadbinder Association
Sulphite Roadbinder as a Product of the Pulp and Paper Industry for Low Cost Maintenance of Roads
Lake States Roadbinder Association, P.O. Box 346, Appleton, Wisconsin.

Lignosol Chemicals Ltd.; CIRCA 1968-9
Lignosol
Lignosol Chemicals Ltd., P.O. Box 2025, Quebec, P.Q.

Lindh, E.; 1981

Dambinding pa Grusuaegar: A Literature Study (Dust Binder on Gravel Roads: A Literature Study)

National Roads and Traffic Research Institute, S-581 ut Linkoping, Sweden.

McKee, J.E. and Wolf, H.W.; 1963

Water Quality Criteria

State of California, State Water Resources Control Board, Second Edition.

Mullholland, R.W.; December 1972

Evaluation of Selective Dust Palliatives on Secondary Roads

Saskatchewan Department of Highways Technical Report 18

Norman, C. and Roberts, B.; August 1984

Lignosulphonates as a Dust Suppressant; An Environmental Assessment

Ministry of Transportation and Communications, Northern Region, North Bay, Ontario.

Ontario Government Interministerial Committee on Waste or Recycling; August 1981.

Report on Dust Suppression Particles on Rural Roads in Ontario

Public Works Canada; 1983

Survey of Dust Treatment and Surfacing Practices of Various Highway Agencies, 1983

Transportation Design and Construction Branch, Public Works Canada.

Saskatchewan Department of Highways and Transportation

Performance of Ca-Lignosulfonate (M & F Road Stabilizer) as a Priming Material - 1981, 82 Field Trials

Research Branch, Saskatchewan Department of Highways and Transportation, Technical Bulletin #206-1

Sherman, W.A., Hopkins, L.L., Lausman, H.A., Cull, J. and Holly, J.
Sulphite Roadbinder Stabilization
Paper from Sulphite Pulp Manufacturers' Research League, Appleton, Wisconsin.

Singer, R.D. Stevens, J.B., Gleason, J.R., Baker, D.A., Baker, T.M. and McEmber, A.V.; June 1982
An Environmental Evaluation of Dust Suppressants: Calcium Chloride and Lignosulphonates
A mining research contract report sponsered by the U.S. Bureau of Mines, by the School of Public Health, University of Minnesota; Bureau of Mines OFR 9-83

Sontowski, D.P. and Vliet, L.B.; December 1977
Lignosulfonate Dust Palliative Evaluation
Geotechnical and Materials Branch, Ministry of Highways and Public Works, Victoria, British Columbia.

Van Bell, J.; July 1977
Paper Mill By-Product Used for Dust Abatement
Department of Public Works, Yakima County, U.S. State of Washington. Public Works, July 11977 pp. 51-52.

Ward, A.A.; July 1958
Mill Waste, A Report on the Use of Pulp Liquor for Dust Control on Gravel Roads.
Unpublished Internal Report by MTC, Ontario then DHO.

Ward, A.A.; May 1960
A Second Report on the Use of Pulp Liquor for Dust Control on Gravel Roads.
Unpublished Internal Report by MTC, Ontario.

APPENDIX A/ SURVEY OF RESPONDANTS

LIGNOSULPHONATE SURVEY

1) What is your current preference for a dust palliative for the gravel roads under your jurisdiction (including municipal roads)?

2) To what extent are the following dust palliatives used in your jurisdiction on a yearly basis:

- Calcium Chloride	Tonne or Gallon
- Magnesium Chloride	"
- Lignin or Lignosulphonate	"
- Waste Oil	"
- Emulsified Oil	"
- Others	"

3) Are you familiar with lignosulphonate as a dust palliative? If applicable, when was the first time lignosulphonate was used within your jurisdiction?

4) Under what trade name, and from what source is the material purchased?

5) Have you carried out any detailed field testing?

6) What are your minimum specifications for this product?

7) What are your recommended application rates per 2 lane km?

25% Solids .... Gal. at a cost of $ ..... (S + A)*

50% Solids .... Gal. at a cost of $ .....

(Other) Solids .... Gal. at a cost of $ .....

*(S + A) = Supply and Apply

8) How do you compare the various dust palliatives (scale of 6)*

	Cost Effect-iveness	Environ-mental Concerns	Road User Preference	Maint. Crew Preference	Occurrence of Potholes after application.
Calcium Chloride					
Magnesium Chloride					
Lignosulphonate					
Waste Oil					
Emulsified Oil					
Others					

*1) Best
6) Worst

9) Has the usage of lignosulphonates on roads been cleared with your environmental authorities?

10) What, if any, are the restrictions in the application of this product?
- climatic conditions?
- application problems?
- environmental concerns?
- road user complaints?
- property owner complaints?
- undesirable partial breakup?
- restricted to low volume road?
- shorter time effectiveness than other products?

11) Application Details
- Do you apply with own resources and equipment?
- If not, what are the terms of your supply and apply contracts?
- What types of roads (by volume) are treated?
- How many applications per season?
- Is there any regrading/scarifying between applications?
- Are all applications of the same strengths?
- If potholes occur after application, how are these treated?

- Is regrading of the treated road comparable to the regrading of the calcium?
- What is your normal seasonal scenario?

	Gal./2 lane km	Strength
First application	.....	.....
Second application	.....	.....
Third application	.....	.....

SURVEY OF RESPONDERS
LIGNOSULPHONATE QUESTIONNAIRE
AUTHORITIES AND RESPONSES
1984

The following is a list of authorities who were given our questionnaire and an indication of their responses. Responses are categorized as:

A - Affirmative
N - Negative
N.R. - No Response
N.A. - Not Applicable

The Remarks Column is used for those affirmative responses which returned details on how they are using or have used lignosulphonates in the past.

RESPONDER & AUTHORITY	RESPONSE	REMARKS
CANADIAN		
1) Mr. L. Nichols, Director Materials Engineering Branch Alberta Department of Transportation Twin Atria Building 4999-98 Avenue EDMONTON, Alberta T5K 2B6	N.R.	
2) Mr. L.M. Wagar, P. Eng. Maintenance Standards Engineer, Ministry of Transportation and High- ways 940 Blanshard Street VICTORIA, British Columbia V8W 3E6 Phone (604) 387-1738	A	Use calcium & magnesium chlorides; dust oils and lignosulphonates. Preference to Deliquescent/ Hygrospic materials but lignosulphonates (50% solids) are preferred in very dry areas.

RESPONDER & AUTHORITY	RESPONSE	REMARKS
CANADIAN		
3) Mr. K.R. Boyd, P. Eng Materials and Research Department of Highways and Transportation Manitoba 1181 Portage Avenue (Annex) WINNIPEG, Manitoba R3G 0T3	A	Calcium Chloride and lignosulphonates are in use. Lignosulphonates on a trial basis since 1980. 2 applications per season - 1st @ 2.0 $1/m^2$ 2nd @ 1.25 - 2.00 $1/m^2$ (25% solids solution)
4) Mr. Gerard Keenan Assistant Director Highway Construction New Brunswick Dept. of Transportation P.O. Box 6000 FREDERICTON, N.B. E3B 5H1	N	Only familiar with Calcium Chloride (liquid).
5) Mr. J.F. O'Reilly Assistant Deputy Minister Government of Newfoundland and Labrador Dept. of Transportation 6th Floor, Atlantic Place Water Street ST. JOHN'S, NFLD.	N	Calcium Chloride used.
6) Mr. Jim Bently Chief, Highways Division Department of Public Works P.O. Box 1320 YELLOWKNIFE, NWT X1A 2L9	N.R.	

RESPONDER & AUTHORITY CANADIAN	RESPONSE	REMARKS
7) Mr. J.G. Irving Director of Maintenance Dept. of Transportation Nova Scotia P.O. Box 186 HALIFAX, Nova Scotia B3J 2N2	N	Used experimentally in 1958. Had problems as the material nearly ruined the distributor. Uses calcium chloride at present
8) Mr. George Trainor Director, Road Maintenance Dept. of Transportation and Public Works P.O. Box 2000 CHARLOTTETOWN, PEI C1A 7N8 Phone: (902) 892-7431	N	Flake Calcium Chloride two to three applications per annum.
9) Dr. Norman Lewis Pulp & Paper Research Institute of Canada c/o Dept. of Chemistry Pulp & Paper Building McGill University 3420 University St. MONTREAL, P.Q. H3A 2A7 P.P.R.I.C. Phone: (514) 697-4110 Cable: PAPRICAN Telex: 05-821541	N.A.	Listed a number of mills that have sold or supplied, spent sulphite liquor and/ or lignosulphonate to various road authorities (Table 1).

RESPONDER & AUTHORITY	RESPONSE	REMARKS
CANADIAN		
10) M. Pierre LaFontaine Director Recherches-Direction des Analyses Ministere des Transports Place Hauteville 238 Etage 700 Boul'd St.-Cyrille E QUEBEC, P.Q. G1R 5H1	N.R.	Trials in North-western Quebec in 1983 by Government of Quebec Ministry of Transportation in co-operation with Tembec Inc.
11) Mr. John Scott Material Research Branch Saskatchewan Highways and Transportation 1610 Park Street REGINA, Saskatchewan S4P 3V7	A	Both Calcium Chloride and Calcium/Sodium lignos. Has been used since 1968. Prefers Calcium Chloride. Application 2 @ 1.0 $1/m^2$ x 2 applications per year (MGF & EDC products used).
12) Mr. Ray Magnuson Highway Maintenance Yukon Dept. of Highways and Transportation P.O. Box 2703 WHITEHORSE, Yukon Y1A 2C6	N.R.	
13) Dr. Alex Bialski Technical Director Temfibre Inc. (Tembec Inc.) C.P. 906 TEMISKAMING, P.Q. JOC 3RO Phone: (819) 627-9505	N.A.	Supplier of Tembind, a calcium/ammonium lignosulphonate whose products were used in Ontario in 1983 & 1984 on a trial basis

RESPONDER	RESPONSE	REMARKS
UNITED STATES OF AMERICA		
1) Dr. Charles E. Dougan Director of Research Bureau of Planning & Research State of Connecticut Dept. of Transportation 24 Wolcott Hill Rd. P.O. Drawer A WETHERSFIELD, Conn. 06109	N	No gravel roads in their jurisdiction but interested in the findings of our project.
2) Mr. Fred Boyce Engineer of Materials & Research Division Maine Dept. of Transportation P.O. Box 1208 BANGOR, Maine 04401	N.R.	
3) Mr. Francis W. Holden Research and Materials Engineer Central Office Massachusetts Dept. of Public Works 100 Nashua Street BOSTON, Mass. 02114	N.R.	
4) Mr. James F. Carlin Secretary, Executive Office of Transportation & Construction 1610 John W. McCormack State Office Bldg. 1 Ashburton Pl. BOSTON, Mass. 02108	N.R.	

RESPONDER & AUTHORITY	RESPONSE	REMARKS
UNITED STATES OF AMERICA		
5) Mr. Richard E. Wegner, P.E. Chief Materials Bureau Dept. of Highways State of Montana 2701 Prospect Avenue HELENA, Montana	N	No gravel roads under their jurisdiction - Suggested U.S. Forest Services, Missoula, Montana, might be able to respond.
6) Mr. Phillip E. McIntyre Materials & Research Engineer Central Office New Hampshire Dept. of Works & Highways John O. Morton Bldg. Hazen Dr. CONCORD, New Hampshire 03301	N.R.	
7) Mr. Jack Sullivan, P.E. Engineer of Materials Dept. of Transportation State Highway Division 135 Transportation Bldg. Capital Mall SALEM, Oregon 97310	A	Used from 1970 - 1979 Currently no palliatives (dust) are used because of long rainfall season. Further details from Mr. J. Sheldrake, Mtce. Operations Engineer Phone: (503) 378-6528
8) Mr. R.L. Fruggiero, P.E. Supervising Civil Engineer Rhode Island Dept. of Transportation - Public Works - Materials 372 State Office Bldg. PROVIDENCE, R.I.	N	Calcium Chloride and/or water used.

RESPONDER & AUTHORITY	RESPONSE	REMARKS
UNITED STATES OF AMERICA		
9) Mr. R.F. Nicholson, P.E. Materials & Research Engineer State of Vermont Agency of Transportation 133 State Street Administration Bldg. MONTPELIER, Vermont 05602	N	Gravel roads are not in their jurisdiction
10) Mr. G. Scott Rutherford Research Director State of Washington Dept. of Transportation Transportation Bldg. OLYMPIA, Washington 98504 Phone: (205) 753-6005	N	Used to stabilize volcanic ash on roadway roadsides after Mt. St. Helen's eruption. Source Georgia-Pacific, St. Regis.
11) Mr. Ray Sherman Assistant Manager Division of Engineering Services Dept. of Natural Resources OLYMPIA, Wash. 98504	N	Pulp & Paper Operations with Timber Companies. Use lignosulphonates on their forest roads.

APPENDIX B/ APPLICATION METHODS

APPLICATION METHOD A

RECOMMENDED METHODS OF APPLICATION USING 35% SOLIDS

1. Grade the road surface 7.6 cm (3 in.) deep to get rid of all the corrugations, pot holes and to loosen the road surface material to the depth penetration desired.

2. Grade the road 5.0 cm (2.0 in.) deep in a manner to leave a windrow on both sides. The distance between the windrows should be 5.5 m (18 ft).

3. Spray the road surface between the windrows.

   Recommended Application rate .91 l/m^2 (.2 gal./sq. yd.)
   Actual Application rate ___ l/m^2 (__ gal./sq. yd.)

4. Using approximately half of the material in the windrows, cover the freshly sprayed dust control product.

5. Spray the road surface between the windrows.

   Recommended Application rate .91 l/m^2 (.2 gal./sq. yd.)
   Actual Application rate ___ l/m^2 (__ gal./sq. yd.)

6. Blade the remainder of the material in the windrow evenly over the freshly applied dust control product.

7. It is important that the finished grade should be left with a crown 4.2 cm per m (1/2 in. per ft.) from the centreline to the edge of the road.

8. Spray the dust control product on the finished grade 6.7 m wide (22 ft.).

   Recommended Application rate .91 l/m^2 (.2 gal./sq. yd.)
   Actual Application rate ___ l/m^2 (__ gal./sq. yd.)

APPLICATION METHOD B

RECOMMENDED METHODS OF APPLICATION USING 35% SOLIDS

1. Grade the road surface 7.6 cm (3 in.) deep to get rid of all the corrugations, pot holes and to loosen the road surface material to the depth penetration desired.

2. Grade the road .1 m (20.0 ft.) wide.

3. Spray the road surface between the windrows.

   Recommended Application rate .91 l/m^2 (.2 gal./sq. yd.)
   Actual Application rate __ l/m^2 (__ gal./sq. yd.)

4. Grade the road surface 5.0 cm (2.0 in.) deep from the right side to the left side and back to the right side, in the same manner as mixing mulch. It might be necessary to make an extra pass with the grader to mix and level the material properly.

5. Spray the road surface again 6.1 m (20.0 ft.) wide.

   Recommended Application rate .91 l/m^2 (.2 gal./sq. yd.)
   Actual Application rate __ l/m^2 (__ gal./sq. yd.)

6. Grade the road surface 5.0 cm (2.0 in.) deep from the left to the right side and back to the left side, in the same manner as mixing mulch. Again it might be necessary to make an extra pass with the grade to mix and level the material properly.

7. The finished grade should be left with a crown of 4.2 cm per m (1/2 in. per ft.) from the centreline to the edge of the road.

8. Spray the dust control product on the finished grade 6.7 m (22 ft.).

   Recommended Application rate .91 l/m^2 (.2 gal./sq. yd.)
   Actual Application rate ___ l/m^2 (__ gal./sq. yd.)

APPLICATION METHOD C

RECOMMENDED METHODS OF APPLICATION USING 35% SOLIDS

1. Grade the road surface 7.6 cm (3 in.) deep to get rid of all the corrugations, pot holes and to loosen the road surface material to the depth penetration desired.

2. Spray the road surface 6.1 m (20.0 ft.) wide.

   Recommended Application rate .91 l/m^2 (.2 gal./sq. yd.)
   Actual Application rate ___ l/m^2 (__ gal./sq. yd.)

3. Allow the dust control product to penetrate into the road surface.

4. Spray the road surface 6.1 m (20.0 ft.) wide.

   Recommended Application rate .91 l/m^2 (2 gal./sq. yd.)
   Actual Application rate ___ l/m^2 (__gal./sq. yd.)

5. Allow the dust control product to penetrate into the road surface.

6. Grade the road surface approximately 2.5 cm (1.5 in.) deep leaving the finished grade with a crown of 4.2 cm per m (1/2 in. per ft.) from the centreline to the edge of the road.

7. Spray the dust control product on the finished grade 6.7 m (22.0 ft.) wide.

   Recommended Application rate .91 l/m^2 (.2 gal./sq. yd.)
   Actual Application rate ___ l/m^2 (__ gal./sq. yd.)

APPLICATION METHOD D

RECOMMENDED METHODS OF APPLICATION USING 35% SOLIDS

1. Grade the road surface 5.0 cm (2.0 in.) deep to get rid of all the corrugations, pot holes and to loosen the road surface material to depth penetration is desired, leaving a crown of 4.2 cm per m (1/2 in. per ft.) from the centreline to the edge of the road.

2. Spray the road surface 6.1 m (20.0 ft.) wide.

   Recommended Application rate .91 l/m^2 (.2 gal./sq. yd.)
   Actual Application rate ___ l/m^2 (__ gal./sq. yd.)

3. Allow dust control product to penetrate into the road surface.

4. Spray the road surface 6.1 m (20.0 ft.) wide.

   Recommended Application rate .91 l/m^2 (.2 gal./sq. yd.)
   Actual Application rate ___ l/m^2 (__ gal./sq. yd.)

5. Again allow the dust control product to penetrate into the road surface.

6. Spray the road surface 6.7 m (22.0 ft.) wide.

   Recommended Application rate .91 l/m^2 (.2 gal./sq. yd.)
   Actual Application rate ___ l/m^2 (__ gal./sq. yd.)

APPENDIX C/ PHOTOGRAPHS OF APPLICATION METHODS

Photo 1/ Preparing grade for Method A.
You will notice a windrow of Granular A on each side of the road.

Photo 2/ Sprayed first application on one side, Method A.

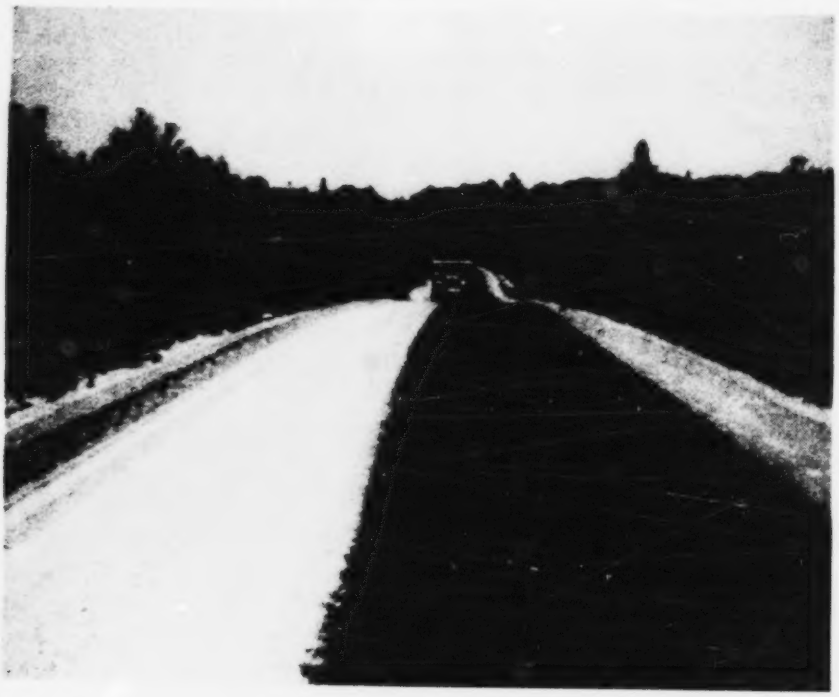


Photo 3/ Completing the spraying of the first application, Method A.

Photo 4/ The first application, Method A, is completed.

Photo 5/ Covering the first application with Granular A from the windrow on the sides, Method A.

Photo 6/ Completing the covering of the first application, Method A.

Photo 7/ Mixing the Tembind and Granular A after the first application, Method B.

Photo 8/ Mixing the Tembind and Granular A after the second application, Method B.

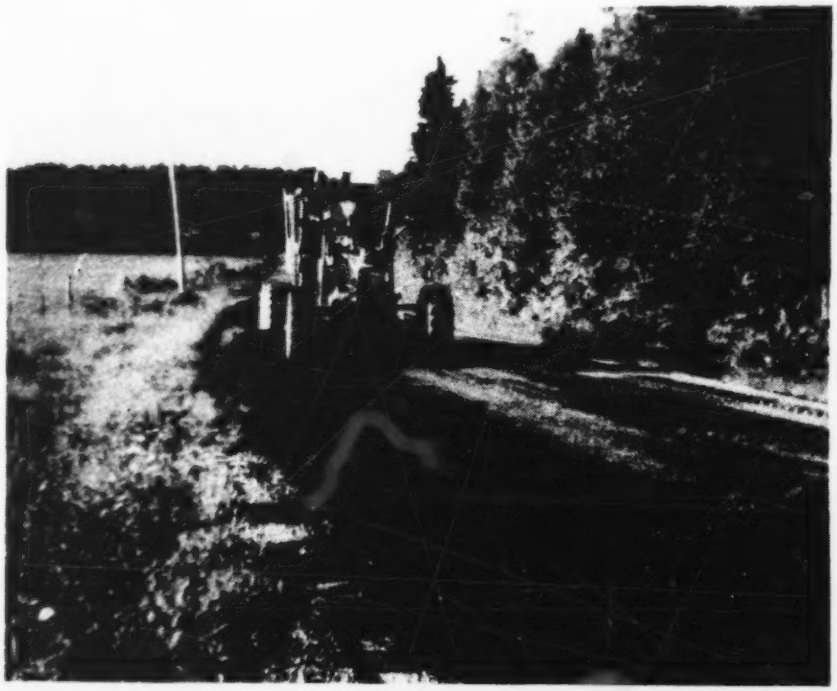


Photo 9/ Mixing the Tembind and Granular A after the third application, Method B.

Photo 10/ Mixing the Tembind and Granular A after the third application, Method B.

Photo 11/ Grading the road very lightly after the second application, Method C.

APPENDIX D/ 1985 ENVIRONMENTAL TEST

memorandum

Ontario

To: Mr. Jack Wear
Secretary
New Products Committee
Research and Development Branch
Central Building, 3rd Floor

Date: 1985 09 30

Re: Tembind - Lignosulphonate

I am attaching a copy of a report to me on environmental investigations conducted on this product by M.O.E., Waste Management Branch. This report indicates that, subject to contrary results from further tests and experience, there is no good reason to prohibit the use of Tembind on environmental grounds.

Please pass this information to the members of the New Products Committee for their consideration and appropriate action.

J.J. Armstrong
Head,
Technical Policy Development Section
Environmental Office

JJA/dmd
Attach.

cc. D. Lynch
W. Zonnenburg
B. Roberts
P. Kerrivin
A. Bialski
J. Smart

AND DEVELOPMENT BRANCH
Ministry of
Transport & Communications

Ministry of the Environment
Ministère de l'Environnement
Ontario

135 St. Clair Avenue West
Suite 100
Toronto, Ontario
M4V 1P5

135 ouest, avenue St. Clair
Bureau 100
Toronto (Ontario)
M4V 1P5

September 18, 1985

Mr. J.J. Armstrong
Head, Technical Policy Section
Environmental Office, MTC
1201 Wilson Ave.
Downsview, Ontario
M3M 1J8

Dear Mr. Armstrong:

Re: Use of Tembind Road Dust Suppressant
on Leo Lake Road

As a result of the meeting held on 16 May, 1985 between MOE, MTC, Can Am Oil Services and Temfibre Inc., to discuss Tembind dust suppressant, a gravel road was treated with the product to test both its efficiency and potential for environmental impairment.

The test road, selected by Can-Am Oil Services, is known as Leo Lake Road, and is about 3 km long, running off Highway 15, 8 km north of Joyceville in S.E. Ontario. The road curves and undulates steeply with few level stretches, and at one point crosses a waterway served by a large culvert. At this point, the road approaches the water to within 1 metre on either side. This particular area was considered good for test purposes, being highly sensitive to dust suppressant overspray or run-off. In upcoming MOE guidelines for the use of road dust suppressants, application of chemicals in such sensitive areas is discouraged. However, for test purposes, the Tembind suppressant was allowed to be sprayed in this location.

Personnel present during the day of the test, June 7, 1985, were the writer, Mr. Murray Cressman of Can-Am Oil Services, Mr. Fred Scott of the township, Mr. Bruce Metcalfe of the MOE Kingston District Office and a representative of the MTC.

INTERNATIONAL YOUTH YEAR 1985
ANNÉE INTERNATIONALE DE LA JEUNESSE 1985

RECEIVED
SEP 25 1985
Environmental Office

Prior to spraying the Tembind, the road was graded. MOE staff sampled the waterway described above to provide background water quality data. Tembind was then sprayed along the length of the road at a rate of approximately 1.5 L/m^2. Visual observations showed that overspray was negligible to non-existant and that the Tembind soaked into, or adhered readily to the road surface, and within 20-30 minutes a vehicle could drive the road with little or no chemical "pick-up". No evidence of run-off or overspray was seen at the water crossing. In addition, although a little odour was noted after spraying the chemical, it could be described as being similar to that of fresh cardboard and not particularly offensive. An hour after Tembind application, the waterway was again sampled by the MOE in the chance that some chemical may have entered the water through subterranean channeling, or short circuit.

Since the test, Mr. Metcalfe of the MOE has visually inspected the road several times over a period of about 2 months and has seen no evidence of run-off. Due to the extremely dark colour of the Tembind, it might be safe to suppose that even with rain dilution, some evidence of surface run-off would be seen. On July 18, 1985, after a particularly heavy rainfall, reportedly the first significant rain since applying Tembind, the water at the road crossing was again sampled. The results of both pre and post Tembind application water samples are shown in the table. It was difficult to select analytical parameters for the samples due to lack of experience with the Tembind. However, due to the strong organic nature of the chemical and the known presence of ammonia, or ammonium compounds, the total Kjeldahl nitrogen test (TKN), the ammonia test (NH_3), the dissolved organic carbon test (DOC), and the dissolved inorganic carbon test (DIC), were felt to be appropriate indicators.

... 3

TABLE OF ANALYTICAL RESULTS

SAMPLE	TKN	NH_3	DOC	DIC	
Before Application 7/6/85	0.48	0.05	4.8	16.0	
1 Hour After Application 7/6/85	0.63	0.09	5.3	16.6)	
	0.47	0.05	4.6	15.8)	2 locations
5 Weeks After Application 18/07/85	0.48	0.04	4.7	14.4)	
	0.50	0.04	4.6	14.8)	3 locations
	0.59	0.07	4.9	15.0)	

All results in mg/L

TKN and NH_3 are expressed as

N - nitrogen, and not as the entire molecule(s)

... 4

While the results vary slightly from place to place, they typify the range of results generally seen on multiple samples in work of this nature, and show no evidence of contamination from an outside source.

Although the test can not be considered entirely definitive, (that would require many weeks of very intensive groundwater and surface water monitoring and analyses, tracer studies, etc.), I feel it served as a good indication that no environmental effect or impairment was measurable at the location under the conditions of the test.

In addition to on-site testing, a sample of Tembind obtained directly from the truck, was returned to the MOE Toronto laboratory for microbiological testwork. Ames tests showed that Tembind is toxic but non-mutagenic to bacteria. While many substances can prove toxic to bacteria if present in high enough concentrations, the mutagenicity test is perhaps of more significatnce as a positive result could have precluded the use of Tembind as a road dust suppressant.

Further biological tests on Tembind are planned, including its toxicity to higher aquatic life forms and fish. Results will be forwarded to you as they become available.

In the meantime, results form this test indicated that there is no good reason to prohibit the use of Tembind as a road dust suppressant and suggest its use may continue unless future experience shows otherwise. The Waste Management Branch is planning a further study to assess the off site impact of applying various dust suppressants. Results from that study will be used to determine the viability of long-term use of various liquid industrial wastes as dust suppressants.

Yours truly,

John Smart
Project Officer
Waste Management Branch

JS/sp
IN 06 18
1899L

APPENDIX E/ TABLE 1: PRODUCTION PARTICULARS, CANADIAN PULP & PAPER MILLS

TABLE 1/ CANADIAN MILLS

COMPANY	CITY	PROV	FINAL PRODUCT	T/DAY	SPECIES	TYPE	BASE	RECOVERY	BY PRODUCT
Abitibi Price Inc.	Pine Falls	NB	Newsprint	130	SW	HyB	Sodium	No	
Consolidated Bathurst	Bathurst	NB	Corrugating medium	315	HW	NaOH	Sodium	No	
Fraser Inc.	Edmunston	NB	Market pulp	592	SW	LyB	Magnesium	B&W/Flakt	
Franer Inc.	Atholville	NB	Market pulp	360	SW	LyB	Magnesium	B&W/Flakt (1983)	
Lake Utopia	St. George	NB	Corrugating medium	250	HW	N	Sodium	No	
New Brunswick Int'ly Paper Co.	Dalhousie	NB	Newsprint	240	SW	HyB	Sodium	No (1982-HyN)	
Bowater Newfoundland Ltd.	Cornerbrook	NF	Newsprint	350	SW	HyB	Sodium	No	
Price (NFLD) Pulp & Paper Ltd.	Grand Falls	NF	Newsprint	230	SW	LyB	Sodium	No (1983-HyB)	
Bowater Mersey Paper Co. Ltd.	Liverpool	NS	Newsprint	160	SW	LyB	Sodium	No	
Nova Scotia Paper Industries	Point Tupper	NS	Newsprint	110	SW	HyB	Sodium	Stora	
			Market pulp	450	SW/HM	TS	Sodium		
Abitibi Price Inc.	Iroquois Falls	ON	Newsprint	300	SW	HyB	Sodium	No	
Abitibi Price Inc.	Thunder Bay	ON	Newsprint	105	SW	HyN	Sodium	No	
Abitibi Price Inc.	Thunder Bay	ON	Newsprint	125	SW	HyB	Sodium	No	
*Boise Cascade Canada Ltd.	Kenora	ON	Newsprint	245	SW	HyB	Sodium	No	
CIP Inc.	Hawkesbury	ON	Dissolving pulp	287	HW	LyA	Ammonium	No	

TABLE 1/ CANADIAN MILLS

COMPANY	CITY	PROV	FINAL PRODUCT	T/DAY	SPECIES TYPE		BASE	RECOVERY	BY-PRODUCT
Domtar	Trenton	ON	Corrugating medium	140	HW	SF	Sodium	No	
*Great Lakes Forest Products Co.	Thunder Bay	ON	Newsprint	315	SW	HyB	Sodium	No	
*MacMillan Bloedel Ltd.	Sturgeon Falls	ON	Corrugating medium	275	HW	N	Sodium	No	
*Spruce Falls Power & Paper Co.	Kapuskasing	ON	Newsprint & tissue	172	SW	LyB	Magnesium	B&W(CA-LyA Shutdown 1982)	
The Ontario Paper Co. Ltd.	Thorold	ON	Sulphite& newsprint	200	BW	LyB	Sodium	Copeland, Alcohol, Vanillin, Sodium Carbonate & Sulfate	
Abitibi Price Inc.	Beaupre	PQ	Newsprint	120	SW	HyB	Sodium	No	Conv. to sulfite treated TMP in 1982
CIP	Matane	PQ	Corrugating medium	230	HW	N	Sodium	No	
CIP Inc.	Trois Rivieres	PQ	Newsprint	260	SW	LyB	Sodium	No	
CIP Inc.	Gatineau	PQ	Newsprint	470	SW	HyN	Sodium	No	
Caupesia Pulp & Paper Co. Ltd.	Chandler	PQ	Newsprint	175	SW	LyB	Sodium	No (1983-HyB)	
Consolidated Bathurst	Shawnigan	PQ	Newsprint	270	SW	HyB	Sodium	No	
Consolidated Bathurst Inc.	Grand'Mere	PQ	Newsprint	150	SW	HyB	Sodium	No	

TABLE 1/ CANADIAN MILLS

COMPANY	CITY	PROV	FINAL PRODUCT	T/DAY	SPECIES	TYPE	BASE	RECOVERY	BY PRODUCT
Consolidated Bathurst Inc.	Port Alfred	PQ	Newsprint	240	SW	HyB	Sodium	No	
Domtar Newsprint Ltd.	Dolbeau	PQ	Newsprint	180	SW	LyB	Calcium	No	
Domtar Newsprint Ltd.	Donnacona	PQ	Newsprint	200	SW	LyA	Calcium	No	
Kruger Pulp & Paper Ltd.	Trois Rivieres	PQ	Newsprint	250	SW	LyB	Sodium	No	
*Papeterie Reed Ltd.	Quebec	PQ	Newsprint	500	SW	LyA	Calcium	No	Lignosulphonate
Papier Cascades	Cabano	PQ	Corrugating medium	240	HW	SF	Sodium	Copeland	Incineration
Quebec North Shore Paper Co.	Baie Comeau	PQ	Newsprint	425	SW	HyB	Sodium	No	
Western Forest Products Ltd.	Port Alice	PQ	Dissolving pulp	450	SW	LyA	Ammonium	C-E	
Rayonier Quebec Inc.	Port Cartier	PQ	Dissolving pulp	750	SW	LyA	Ammonium	C-E	Shut down since 1978
St. Raymond Paper Ltd.	Desbiens	PQ	Market pulp	150	SW	LyA	Magnesium	No	
*Tembec Inc.	Temiscaming	PQ	Diss/Market pulp	550	SW/HW	LyA	Ammonium	Yes	1/2 of liquor burned to generate steam, remainder lignosulphonate.

TABLE 1/ CANADIAN MILLS

COMPANY	CITY	PROV	FINAL PRODUCT	T/DAY	SPECIES	TYPE	BASE	RECOVERY	BY-PRODUCT
The Donohue Company Ltd.	Clermont	PQ	Newsprint	150	SW	LyB	Sodium	No	
The James Maclaren Co. Ltd.	Buckingham	PQ	Newsprint	130	SW	HyB	Sodium	No (HyB-1982)	
The Price Co. Ltd.	Alma	PQ	Newsprint	240	SW	HyB	Sodium	No	
The Price Co. Ltd.	Kenogami	PQ	Newsprint	210	SW	-	Sodium	No sulfite	Treated TMP

*Have sold or are selling lignosulphonates

NOTE:1. Many mills do not have the ability to recover and concentrate their SSl to 20 - 25% solids.
2. In addition, sales of spent sulphite liquor/lignosulphonates for this purpose are regional.

LEGEND

LyB - Low yield disulphite, HyB - High yield disulphite, LyA - Low yield acid sulphite, N - Neutral sulphite
SF - Sulphur free, GL - Green liquor, TS - 2 Stage Stora, HyN - High yield neutral sulphite

SOURCE

Pulp and Paper Research Institute of Canada, May 1984

APPENDIX E/ TABLE 2: TEMBIND 35 ROADWAY SITES

TABLE 2/ TEMBIND 35 ROADWAY SITES

LOCATION	DATE OF APPLICATION	APPLICATION RATE L/m²	DUST CONTROL RATING	DEGREE OF POTHOLING	NO. TIMES GRADED AFTER APPLICATION	DATE OF APPLICATION	TYPE OF MATERIAL	APPLICATION RATE L/m²	DUST CONTROL RATING	DEGREE OF POTHOLING	NO. TIMES GRADED AFTER APPLICATION
Twp. of Casey Lot 4-6 Con V	84 06 13	3.96	Good	Light	6	84 06 13 Lot 1-6 Con III, IV, & V	CaC_2	0.83	Fair	Light	5
Town of Bracebridge	84 06 13	1.49	Fair-Poor	Light	1						
Stephen's Bay Road	84 07 18	1.34	Fair		1						
Spence Twp. Ahmic Lake Rd.											
Method A	84 06 20	3.72	Poor	Moderate	?	84 06 20	Road Oil	1.24	Good	Light	?
Method B	84 06 20	3.72	Fair-Poor	Light	?	Spence Twp.					
Method C	84 06 20	3.72	Fair Poor	Light	?						
Method D	84 06 20	3.72	Poor	Moderate	?						
Twp. Georgian Bay, District Rd. 33											
Method B	84 06 21&22	5.73	Good	Nil-Light	-						
Method C	84 06 21&22	5.87	Good	Light	-						
Method D	84 06 21&22	4.18	Fair-Good	Moderate	-						

TABLE 2/ TEMBIND 35 ROADWAY SITES

LOCATION	DATE OF APPLICATION	APPLICATION RATE L/m²	DUST CONTROL RATING	DEGREE OF POTHOLING	NO. TIMES GRADED AFTER APPLICATION	DATE OF APPLICATION	TYPE OF MATERIAL	APPLICATION RATE L/m²	DUST CONTROL RATING	DEGREE OF POTHOLING	NO. TIMES GRADED AFTER APPLICATION
Parry Island Indian Reserve Wasausirk Rd.											
Method B	84 07 03	5.32	Poor	Heavy	Had to Oil the Road	84 07 03	Road Oil	1.74	Good	Light	?
Method B&D	84 07 03	5.32	Poor	Heavy							
South Sequin Estates Rd.											
Method B	84 07 04	4.77	Poor	Moderate	3	84 07 04	Road Oil	1.24	Good	Light	1
Town of Milton	84 05 17	1.58	Fair	Moderate	2[1]	84 05 17	Waste Oil	1.41	Good	Light[4]	0
Town of Milton	84 09 14	1.79	Fair	Moderate	2[1]	-	-	-	-	-	-
Town of Thornbury	84 06 04	0.76[1]	Good	Light	0	84 05 24[1]	Waste Oil	1.09[1]	Good	Light	0
Town of Thornbury	84 07 31	0.76[1]	Good	Moderate	0	-	-	-	-	-	-
St. Lawrence Seaway (St. Catherines)	84 06 04	3.75[1]	Good	Light	0	-	-	-	-	-	-
Township of West Lincoln	84 06 05	2.23	Fair	Moderate	2	84 05 31[1]	Calcium Chloride	3.38[5]	Fair	Moderate	2[1]
Walpole Island	84 06 06	2.45[1]	Fair	Moderate	-	-	-	-	-	-	-

TABLE 2/ TEMBIND 35 ROADWAY SITES

LOCATION	DATE OF APPLICATION	APPLICATION RATE L/m²	DUST CONTROL RATING	DEGREE OF POTHOLING	NO. TIMES GRADED AFTER APPLICATION	DATE OF APPLICATION	TYPE OF MATERIAL	APPLICATION RATE L/m²	DUST CONTROL RATING	DEGREE OF POTHOLING	NO. TIMES GRADED AFTER APPLICATION
Town of St. Mary's Concession 19	84 06 12	1.90[2]	Good	Light	0	84 06 05[1]	Calcium Chloride	3.38[5]	Good	Light	0
Town of St. Mary's Various Streets	84 06 12	1.09[1,2]	Fair	Light	0	-	-	-	-	-	-
Town of Bracebridge Robert Dollar Dr.	84 06 13	1.85[3]	Fair	Heavy	0	-	-	-	-	-	-
Township of Pittsburg	84 06 14	2.34	Good	Light	0	-	-	-	-	-	-
Township of Tiny	84 06 14	2.83	Good	Light	3	84 06 07	Waste Oil	1.36[1]	Good	Light	3
Township of Tecumseh	84 06 22	2.23	Good	Moderate	3	84 06 05[1]	Waste Oil	1.79[1]	Good	Moderate	3
Township of Palmerston North and South	84 06 26	-	Fair	Moderate	1	-	-	-	-	-	-
Canonto											

NOTES

1. Estimated
2. Original Application Rate. A second Light Application (0.82 L/m² +/-) was placed 2 weeks later.
3. Graded to a depth of 4 cm before application of Tembind.
4. Small breaks in the stabilized oil surface were spray patched with asphalt emulsion and aggregate.
5. Tonnes of liquid calcium chloride per km.